How Cheatgrass Won the West
Lessons for Wyoming

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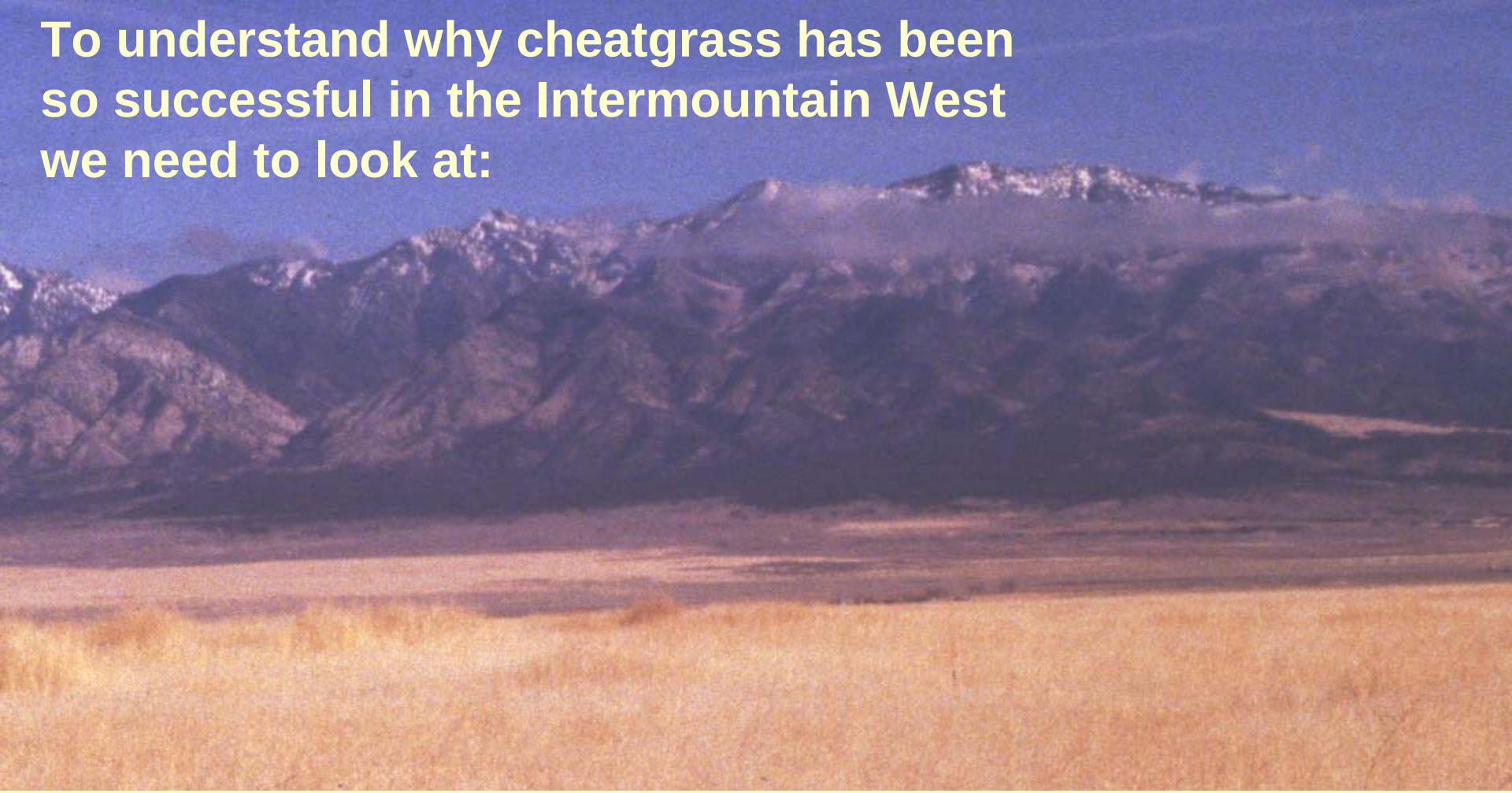
Research Interests

- Seed and seedling establishment ecology and seed propagation of Intermountain native plants.

- Regeneration biology of dominant shrub species, including big sagebrush, antelope bitterbrush, and shadscale.

- Ecological restoration of Intermountain native plant communities.

- Cheatgrass ecology and biocontrol.



To understand why cheatgrass has been so successful in the Intermountain West we need to look at:

- **Life History Strategy**
- **Population Genetics**
- **Role in Vegetation Dynamics**

Cheatgrass Life History Strategy

- Life cycle
- Germination timing
- Seed dispersal
- Seed bank dynamics

Facultative Winter Annual Life History

- Seedling emergence occurs from late summer to early spring.
- Plants grow best at cool temperature.
- Winter chilling (vernalization) is required for flowering.
- Plants flower in late spring.
- Seeds ripen in early to midsummer.

Cheatgrass Seed Germination

Cheatgrass seeds are dormant when dispersed in early summer, and must lose dormancy under dry summer conditions in order to be ready to germinate in fall.

All the seeds are nondormant in fall, but under dry conditions, some do not germinate. These may germinate in the spring or may enter secondary dormancy under winter conditions.

Cheatgrass Seed Dispersal

- Long distance dispersal in crop seed or ballast.
- Mid-range dispersal on fur and clothing.
- Small-scale dispersal by rodents and ants.
- Dispersal by wind.

Cheatgrass Seed Bank Dynamics

Most cheatgrass seeds germinate within a year of their production and dispersal.

There is more seed bank carryover across years in habitats with dry fall weather.

Seed bank carryover across years prevents local extinction following catastrophic stand loss.

Cheatgrass Population Genetics

How does

phenotypic plasticity

in combination with

genetic variability

make cheatgrass so successful?

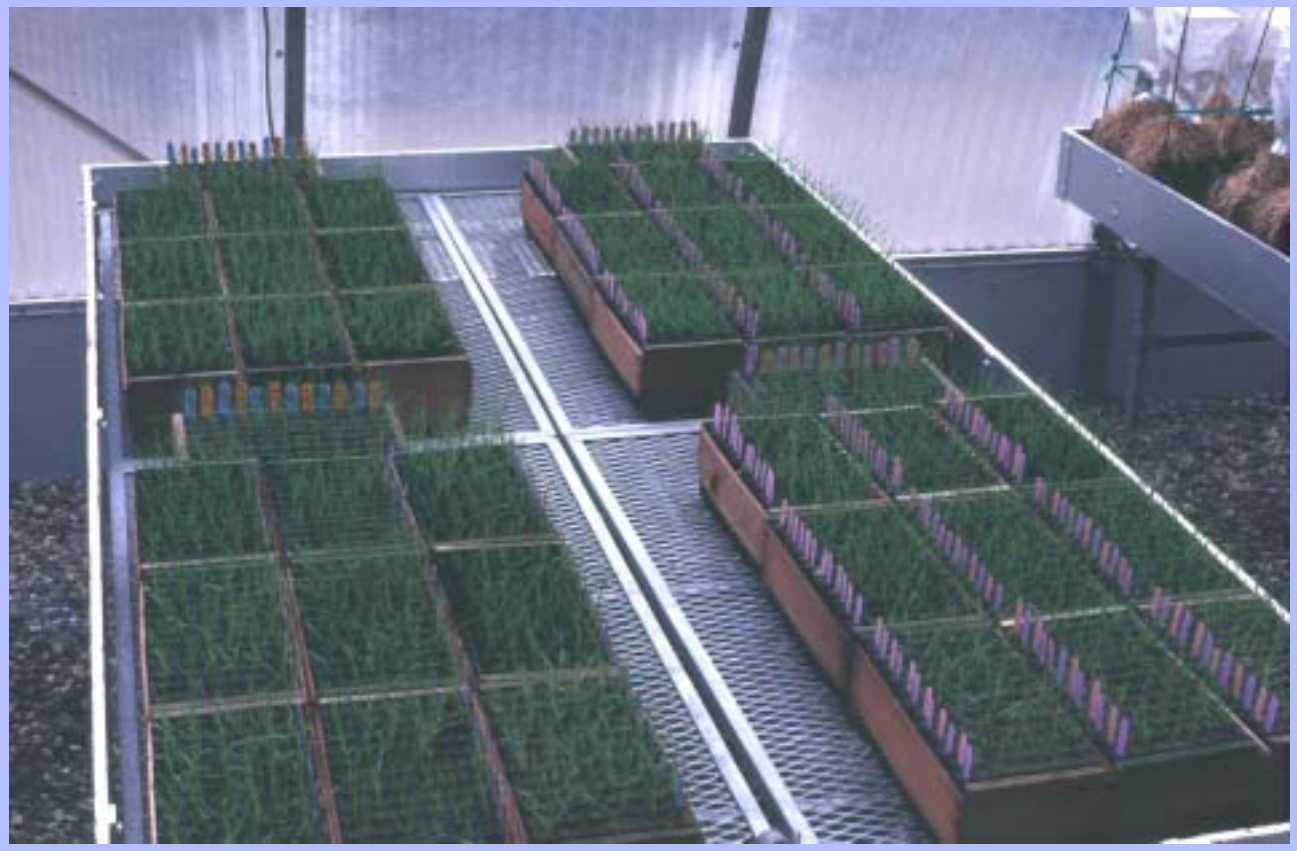
Phenotypic Plasticity

- **Phenotypic plasticity is variation caused by differences in environmental conditions.**
- **Most variation in cheatgrass emergence time, plant size, and seed production is due to phenotypic plasticity.**
- **Extreme plasticity in response to resource availability is a key feature of the cheatgrass strategy for success.**

Breeding System

- **Cheatgrass has a highly selfing breeding system.**
- **Cheatgrass populations are made up of inbreeding lines that rarely if ever cross with one another.**
- **New genotypes normally enter a population only through mutation or through migration, not through sexual recombination.**

Adaptively Significant Genetic Variation



Cheatgrass inbreeding lines often show genetic differences in adaptively significant traits. We study these differences using experiments in controlled environments.

Genetically Based Variation

- **Different cheatgrass genotypes can be detected using molecular genetic markers.**
- **The number of genotypes in a population depends on the interplay between migration and natural selection.**
- **The rate of migration of new genotypes into a population depends on the size, proximity, and genetic diversity of source populations.**

Whether a newly-introduced genotype persists depends on its adaptation for survival in the new habitat.

Vegetation Dynamics

What factors affect the susceptibility of a plant community to cheatgrass invasion?

- **Climate**
- **Intrinsic soil fertility**
- **Plant competition**
- **Disturbance regime**
- **Proximity to source populations**
- **Effectiveness of dispersal agents**

The Invasion Process

Cheatgrass is often present at low frequency even in undisturbed plant communities.

But massive disturbance is generally required to open the plant community sufficiently to permit cheatgrass takeover.

If the disturbance is caused by excessive livestock grazing, the disturbance agents also act as effective seed dispersers and accelerate the invasion process.

Some other factors that increase the ability of cheatgrass to displace a native plant community:

- **Unusual weather cycles.**
- **Disease and insect outbreaks on native species.**
- **Cryptobiotic crust degradation.**
- **Increases in soil fertility, especially nitrogen.**

Cheatgrass Creates Its Own Disturbance

The Role of Wildfire

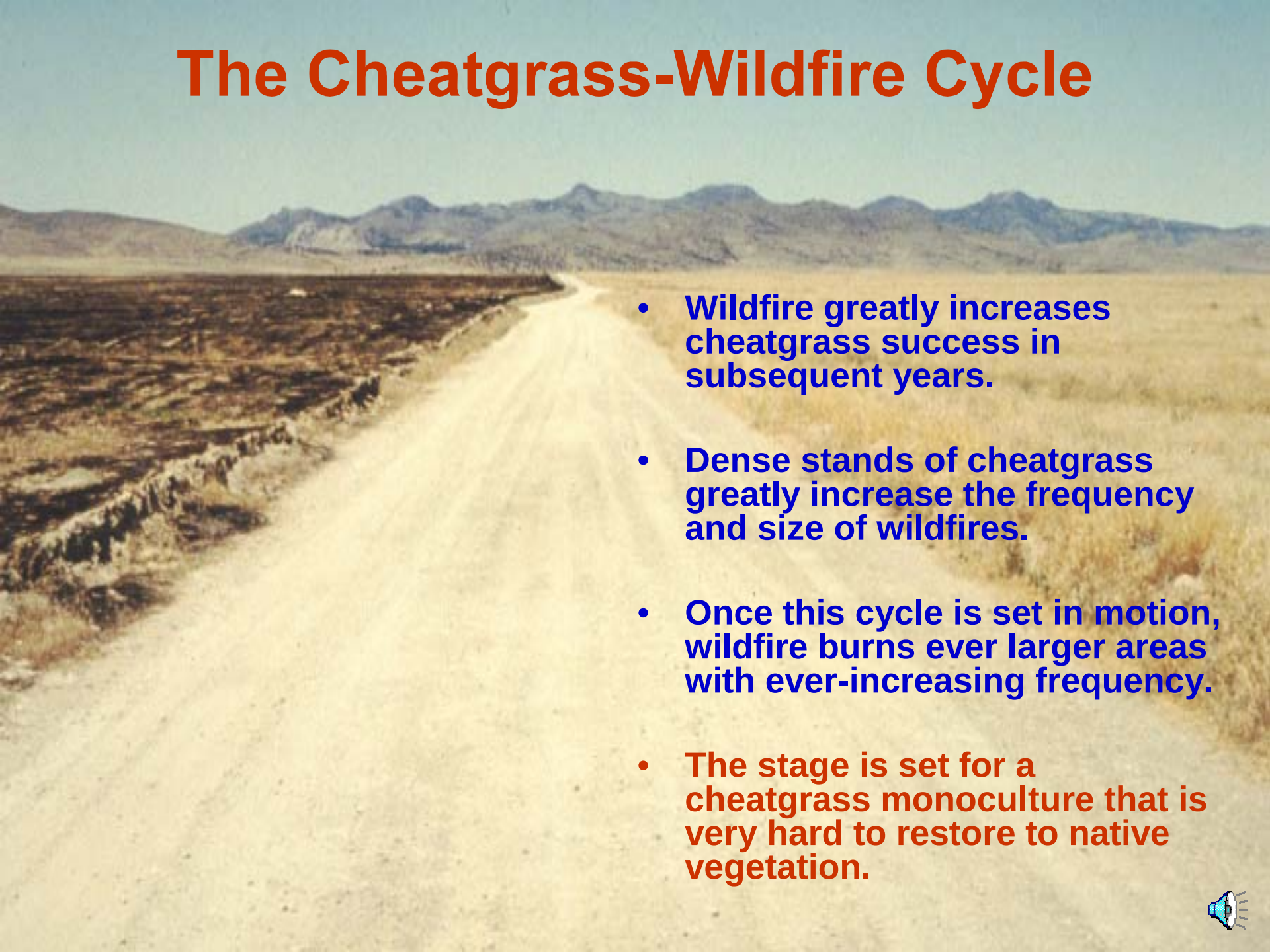
Once cheatgrass forms a continuous stand in the understory of an invaded shrub community, wildfire is inevitable.

Effects of Wildfire

- Kills most desert shrubs outright.
- Greatly increases soil fertility.
- Decreases competition for water and nutrients.
- Prevents seed dispersal of late-maturing natives.

Because cheatgrass seeds disperse early, many can survive wildfire in the soil.

The Cheatgrass-Wildfire Cycle



- Wildfire greatly increases cheatgrass success in subsequent years.
- Dense stands of cheatgrass greatly increase the frequency and size of wildfires.
- Once this cycle is set in motion, wildfire burns ever larger areas with ever-increasing frequency.
- The stage is set for a cheatgrass monoculture that is very hard to restore to native vegetation.

Restoring a Cheatgrass Monoculture

Seeding natives directly into a cheatgrass monoculture almost always fails.

Some form of cheatgrass control prior to seeding is necessary to improve the chances of success.

Methods for Cheatgrass Control

- Mowing
- Tillage
- Herbicides
- Early season burning
- Biocontrol

Cheatgrass Biocontrol

We are engaged in a major research project on cheatgrass biocontrol with head smut disease, caused by the smut fungus *Ustilago bullata.*

This biocontrol agent shows some promise.

Conclusions

Do not assume that a plant community cannot be invaded and displaced by cheatgrass.

Manage as if the threat is real:

Minimize disturbance.

Minimize potential dispersal.

Prevent human-caused wildfires.

Protecting existing plant communities is far more cost-effective and practical than restoring cheatgrass monocultures.